JET PROPULSION LABORATORY INTEROFFICE MEMORANDUM

April 21, 2003

IOM ECH0003-2003-16

TO: Eugene Burke

FROM: E. C. Hampton

SUBJECT: Deep Space Station-27 Out-of-Service Assessment Report

INTRODUCTION

It has been proposed that Deep Space Station-27 (DSS-27) be removed from service as early as 2004. DSS-27, a High Speed Beam-Waveguide (34HSB) antenna provides tracking support for Low Earth Orbiter (LEO), High Earth Orbiter (HEO), and some S-band missions. The Resource Allocation Planning and Scheduling Office (RAPSO) have performed a loading assessment within the scope of the RAPSO operational database to determine the impact on ongoing user tracking support requirements if DSS-27 is removed from service.

Background

The tracking support capabilities of DSS-27 are limited to LEO, HEO, and some S-band missions. The available capabilities allow this antenna to support a number of S-band missions that contribute to the forecast of high unsupportable tracking hours on the 26-meter (26M) and 34-meter beam waveguide 1 (34B1) Subnets. Deep Space Station-27 is utilized to support the tracking requests of missions such as Advance Composition Explorer (ACE), Chandra, and the International Solar-Terrestrial Physics Program missions, Cluster II, GEOTAIL, POLAR, and SOHO. All of the above missions require S-band uplink and downlink and viewperiods overlap from 25 to 100 percent. DSS-27 is also used to provide tracking support to these users when the 26M Subnet is providing launch and initial acquisition support to various new missions.

Deep Space Network antenna downtime is planned for several engineering, hardware, and software upgrades affecting all DSN complexes during the 2003 through 2007 time period. Scheduled and proposed downtimes adversely affect the loading on the entire network.

Primary plans and negotiations at the annual Resource Allocation and Review Board (RARB) meeting have already agreed to The Mars overload, a period of mission critical activities and events, which is planned for late 2003 through the first quarter of 2004. DSS-27 plays a major role in providing tracking support to the LEO, HEO, and some S-band missions during this time period.

OBJECTIVES OF THE STUDY

1. To perform an assessment of user loading on the DSN 34HSB, 34B1, and 26M Subnets to determine any impact on meeting ongoing mission tracking requirements in 2003 through 2007 if DSS-27 is removed from service.
2. To determine the utility in keeping DSS-27 in-service from 2004 through 2007.
3. To identify significant and critical events and planned major antenna downtimes that will affect the network loading in the 2004 through 2007 time period.

DSN ANTENNA RESOURCE ASSESSMENT AND IMPACT ANALYSIS

The 34B1 and 26M subnets have similar capabilities as the 34HSB, in that they have S-band uplink and S-band downlink capability. The 34B2 subnet does not. Therefore, some S-band missions requesting tracking support on the 26M or 34B1 antennas are moved as needed to the 34HSB. The annual network load and utilization percentages on the 34B1 and 26M subnets for 2003 through 2007 show that these subnets are fully subscribed, and DSS-27 provides the needed additional capacity to support NASA's LEO and HEO missions.

Table 1 shows the annual requested hours per subnet for 2003 through 2007. Table 2 shows the annual lost hours by subnet, and Table 3 provides the percent utilization of these subnets.

TABLE 1: ANNUAL REQUESTED TIME BY SUBNET (HOURS)

YEAR	2003	2004	2005	2006	2007
34B1	15,803	17,777	15,426	16,997	15,829
34HSB	2,929	2,808	2,637	2,260	2,544
26M	15,944	16,828	16,325	15,378	13,2560

TABLE 2: Annual Lost Time by Subnet in Hours

	YEAR	2004	2005	2006	2007
34B1	1253	1104	866	1037	849
34HSB	196	169	181	78	182
26M	1376	1298	1469	1080	1184

TABLE 3: Annual Percent Utilization

	2003	2004	2005	2006	2007
34B1	60%	68%	59%	65%	60%
34HSB	33%	32%	30%	26%	29%
26M	61%	64%	62%	59%	51%

Projected unsupportable time ranges from 10 percent to 20 percent. The 26M and the 34B1 projected unsupportable time of 15 per cent or less is considered low and can normally be resolved during the RAPSO Mid-Range Conflict and Negotiation meeting. However, the remaining 5 per cent and all of the DSS-27 tracking support may be lost if DSS-27 is removed from service.

When 26M Subnet tracking support is displaced due to one reason or another, the DSS-16 support is moved onto DSS-27 and to DSS-24 if time is available. When this happens, there is loss of tracking support and data for users. In general, the loss of 10 to 20 percent is not considered a great loss of data, but when lost tracking hours for the subnets are combined together, it can be a major loss in tracking support and data for the users.

In 2003, the RAPSO forecast data show that 2,929 hours of project or mission support time was requested on the DSN 34HSB. These requested support hours are those hours that cannot be fulfilled on the 26M or 34B1 subnets. Therefore the projects or missions requesting DSS-27 support will lose valuable tracking support time if DSS-27 is removed from service in 2004 since both the 26M and 34B1 are at capacity (greater than 60% utilization). The following are a few of the users and events that will be impacted if DSS-27 is removed from service:

SOHO TSO (Temporal Solar Observation), an experiment that occurs every 30-days and requires continuous coverage for five-days. The SOHO HSO (Helioseismology Observation) experiment occurs once a year, the initial requirement is for 60-days of continuous support and an additional 30-days of continuous support on a best efforts basis. DSS-27 provides approximately one third of the support hours for the SOHO HSO experiment. The SOHO HSO experiment was broken into two parts in 2003 due to the Mars overload and critical events period. The total hours of nominal support at DSS-27 averages out to approximately 40 hours per week. Thirty to forty-five additional support hours are added for SOHO HSO experiment each year (see Charts 1-5 for DSS-27 HSO support). These experiments depend heavily on tracking support provided by DSS-27.

Cluster II will require DSS-27 to support the 4-station array for Wide Band Data (WBD) gathering. DSS-14 and DSS-15 are not readily available due to the number of Mars missions requesting 70M and 34HEF support.

POLAR will be greatly impacted if DSS-27 is removed from service. DSS-27 is used to provide TCM support and to fulfill the gaps in their day to day real-time, and data playback routine support that cannot be met on the 34B1 and 26M subnet due to their over subscription.

CHANDRA will experience unsupportable time especially during the Mars overload period due to critical Mars support, mission events, and other users events that over subscribes the 34B1 and 26M Subnets.

The end-of-mission (EOM) date has been changed for a number of the ongoing missions. Some missions that were scheduled to end support in 2004 have been changed or extended to end support in September of 2006 and or 2007.

The network user loading for 2005 through 2007 projects a 90 to 98 percent supportable time on the 34B1 Subnet and a 89 to 97 percent supportable time on the 26M Subnet with DSS-27 in service. The monthly user supportable percentage of time with DSS-27 decommissioned ranges from 90-96 percent on the 34B1 Subnet and 81-93 percent on the 26M Subnet (see Charts 6 and 7). During this time period, the 34 HEF is oversubscribed with the Cassini probe release and entry in January, Deep Impact support for comet approach, encounter and impact in July, and Mars Reconnaissance Orbiter (MRO) launch in August of 2005 which will cause an overflow of 34HEF user support requirements onto the 34B1 Subnet. In 2006, the 34HEF and 34B1 are oversubscribed with Messenger Venus flyby in February, DAWN scheduled to launch in May, MRO Mars approach in January, and Mars orbit insertion, and aerobraking in March. In 2007, another Mars mission launch, Mars Competed Scout, in August, Lunar-A in August and New Horizons Pluto Charon Jupiter approach and flyby in July will all contribute to the 34HEF and 34B1 being overloaded (see Major Events Table for 2005-2007).

The 26M and 34B1 Subnets unsupportable time in 2005-2007 is considered low, less than 15 percent without DSS-27. However with the oversubscription of the 34HEF at this time, the 34B1 and 26M Subnets load may increase significantly as RARB activities recommend shifting the loads to these subnets to accommodate the capacity of the 34HEF subnet.

The 34B1 Subnet monthly supportable percentage of time with and without DSS-27 is shown in Chart 6. The 26M Subnet monthly supportable percentage of time with and without DSS-27 is shown in Chart 7.

CONCLUSIONS AND RECOMMENDATIONS

The primary focus of this study is to determine the impact of removing DSS-27 from service on user loading. The present User loading on the 26M and the 34B1 Subnets show these subnets to be fully subscribed from 2003 through September 2007. DSS-27 is utilized to support the overflow of tracking support requirements from the 26M and the 34B1 Subnets. Presently, less than 10 percent of the tracking support requirements are forecast as unsupportable. The total requested tracking support hours at DSS-27 ranges from approximately 2,200 to 2,900 hours per year (~30% utilization). These hours may be lost if DSS-27 is removed from service.

This study found that DSS-27 is a very useful and important antenna in providing needed additional tracking capacity support for a number of missions, in particular, the ISTP missions. The 34HSB, the 26M Subnet, and the 34B1 Subnet are the only antennas remaining under the DSN umbrella that have S-band uplink and downlink capability to support the ongoing S-band mission set in LEO and HEO. DSS-27 provides tracking support for the ISTP missions, especially SOHO, CLUSTER, GEOTAIL, and POLAR. The loss of DSS-27 will impact on the SOHO's TSO and HSO experiments. Tracking support for POLAR, GEOTAIL, and ACE will be at risk.

The forecast planning for 2003 and the first quarter of 2004 have been completed. The Mid-Range Planning Team has negotiated over one half of the RAPSO

Mid-Range Planning Schedule to resolve tracking support conflicts through late August of 2003. The Mars overload (see Events Table 1 and 2 for 2003 and 2004 Major Events) period from December 2003 through the first quarter of 2004 is scheduled for negotiations in June 2003. To remove DSS-27 from service in 2004 would result in a major increase in time and effort to negotiate conflict free schedules for 2004. Removing DSS-27 from the mix may add substantial risk to the success of the Mars Exploration Rovers because of increased competing demands for tracking from the Mars Program and the ISTP missions for the 34B1 antennas. This is not recommended.

The support requirements in 2005-2007 are nominal and the unsupportable time on the 34B1 and 26M Subnets is less than 15 percent with or without DSS-27. The user load without DSS-27 causes a 10 to 20 percent loss of time.

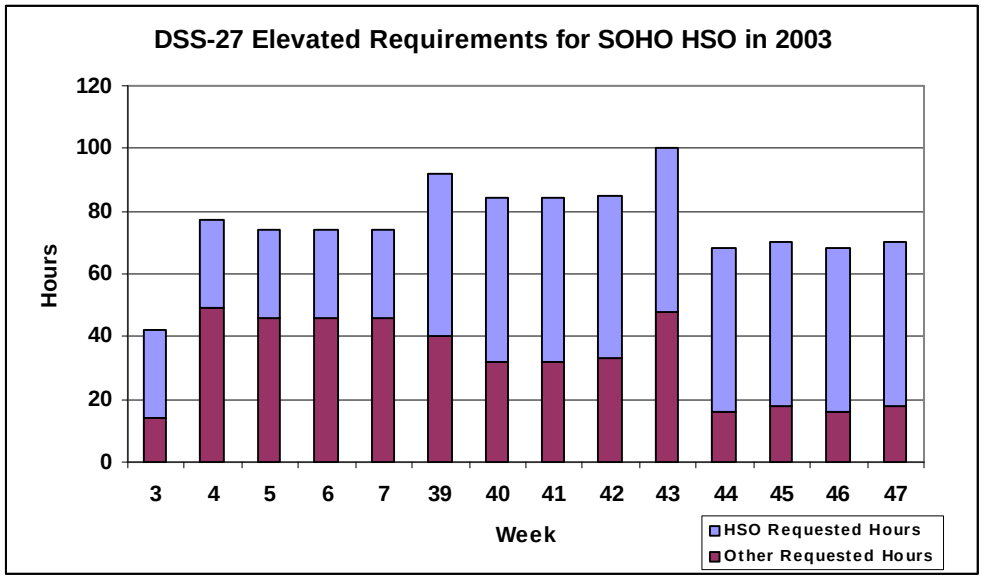
The users do not regard the DSS-27 antenna in the "A" category of antennas in providing tracking and ranging support, but they do regard it as the antenna that is available to provide needed support when there is no other antenna available. The ISTP missions will be greatly impacted if DSS-27 is decommissioned. Therefore, it is strongly recommended that DSS-27, the 34HSB, antenna remain in service through September 2007.

Cc: Arthur Andujo
Roger Bartoo
Eugene Burke
Kevin Kim
Napoleon Lacey
Kathryn Martinez
David Morris

Supporting Data:

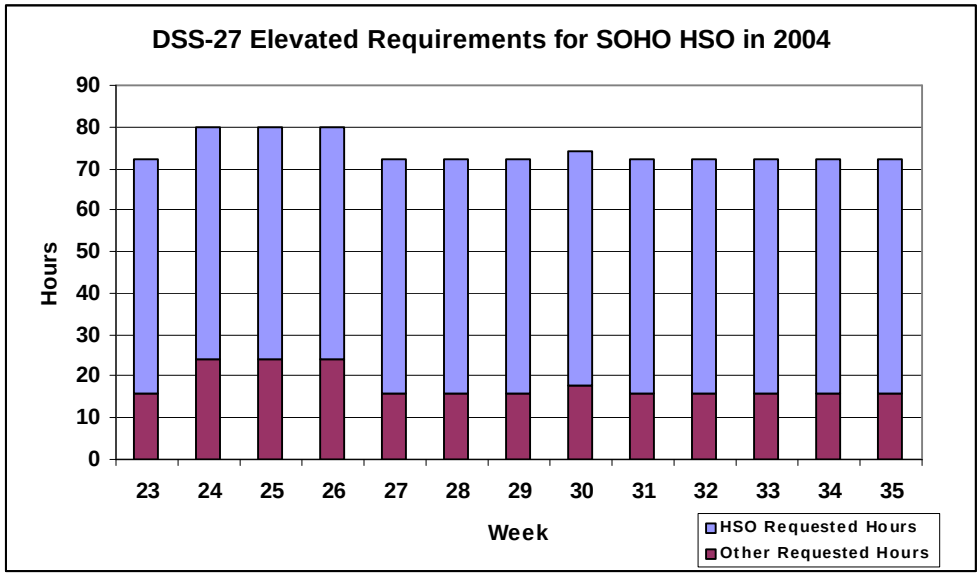
DSS-27 support request during the annual SOHO HSO Experiments

Chart 1: Requested support and HSO support for 2003



.

Chart 2: Requested support and HSO support for 2004



Supporting Data cont.

DSS-27 support request during the annual SOHO HSO Experiments

Chart 3: Requested support and HSO support for 2005

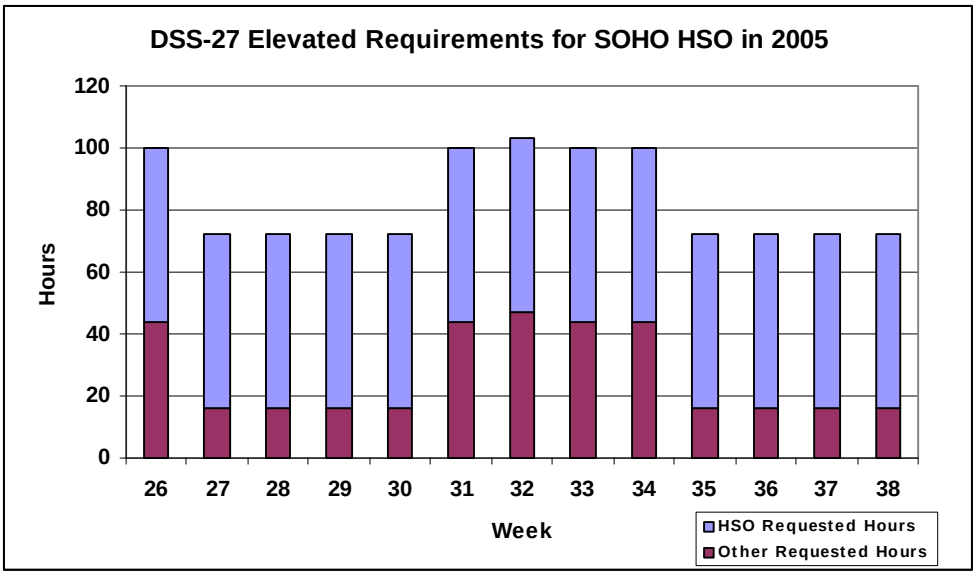
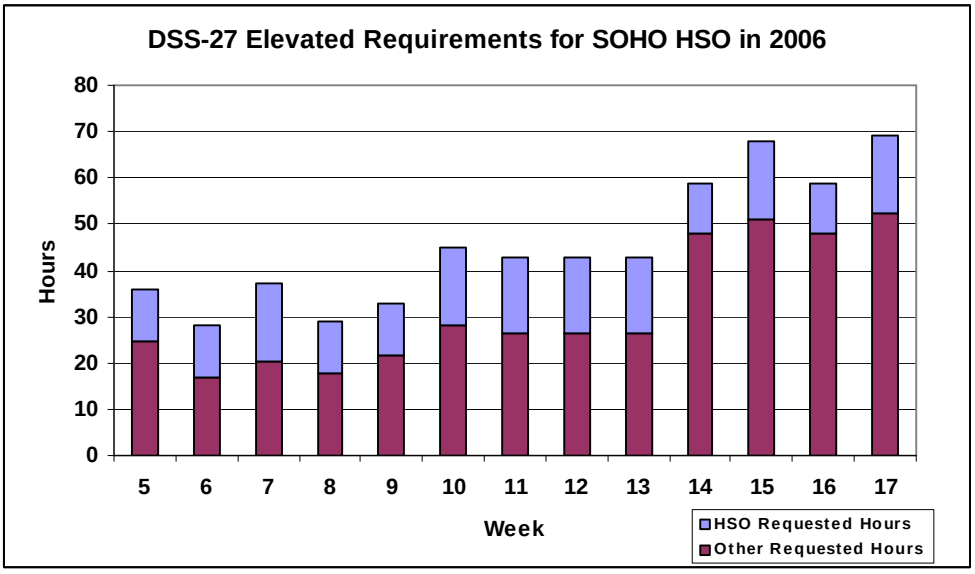


Chart 4: Requested support and HSO support for 2006



Supporting Data cont.

DSS-27 support request during the annual SOHO HSO Experiments:

Chart 5: Requested support and HSO support for 2007

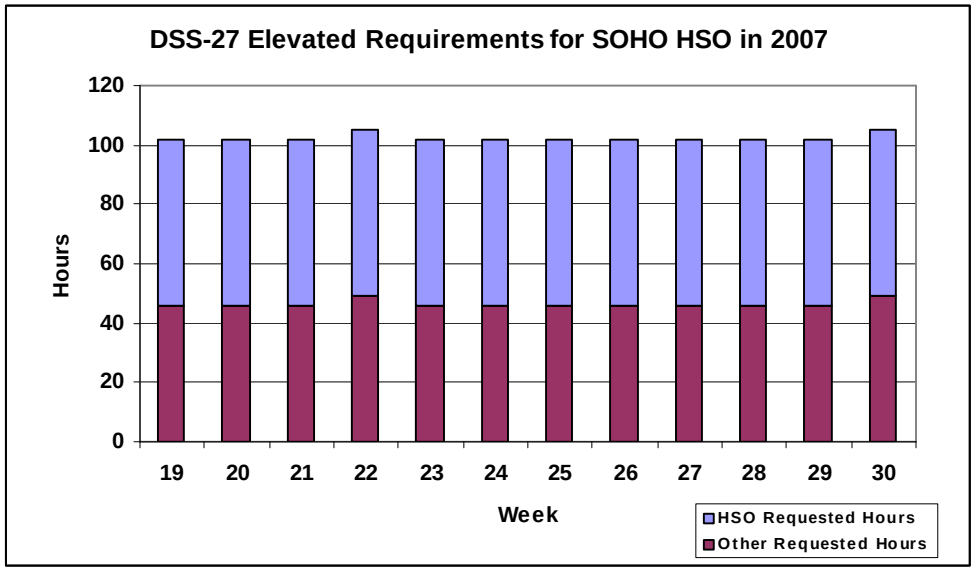
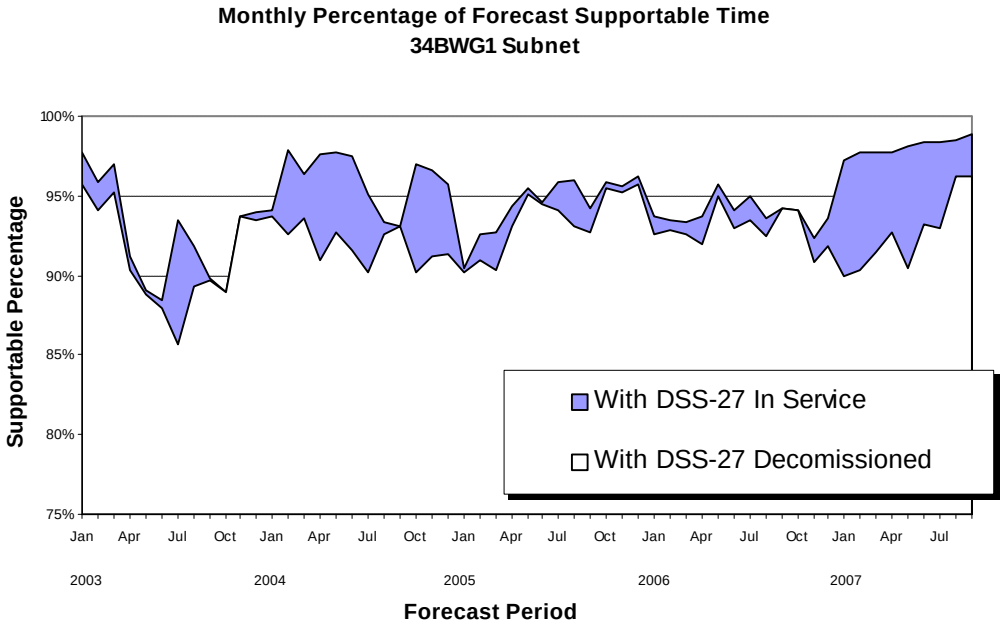
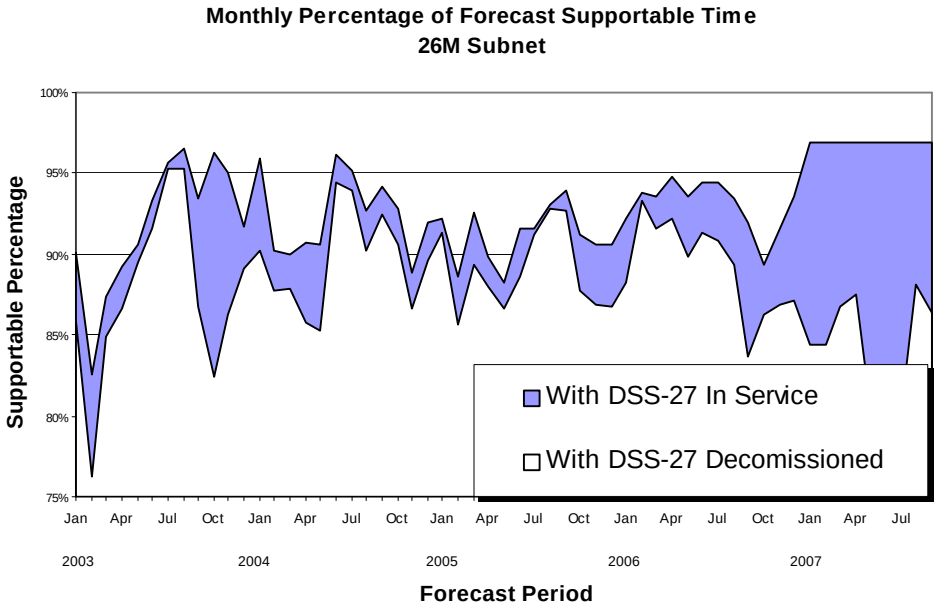


Chart 6: 34B1 Monthly Percentage of Supportable Time



Supporting Data cont.

Chart 7: 26M Monthly Percentage of Supportable Time



Supporting Data cont.

Major Events for 2003-2007

TABLE: 1 Major Events for 2003

PROJECT	2003 EVENTS
Cassini	Gravity Wave Experiment October 2003 Saturn Approach December 2003
Galileo	Jupiter Impact September 2003
GSSR	Asteroid 1998FH12 June 2003 Asteroid 1994PM August 2003 Asteroid 1999CU3 September 2003 Asteroid 1990S November 2003 Asteroid 1996GT November 2003
ISTP SOHO	HSO September 2003
MER1	Launch June 2003 Mars Approach December 2003
MER2	Launch May 2003 Mars Approach November 2003
Mars Express Orbiter	Launch May 2003
MUSES-C	Launch May 2003
Mars Express Orbiter	Mars Approach November 2003 Mars Orbit Insertion December 2003 Mars Capture December 2003
NOZOMI	Earth Swingby June 2003 Mars Approach November 2003 Mars Arrival December 2003
Stardust	Deep Space Maneuver 3 June 2003
SIRTF	Launch August 2003
Voyager 1	MAGROL Maneuver DTR Array Playback ASCAL Maneuver
Voyager 2	MAGROL Maneuver DTR Playback ASCAL Maneuver

Supporting Data cont.

TABLE: 2 Major Events for 2004

PROJECT	2004 EVENTS
CASSINI	TCM and Critical Sequence June 2004 Saturn Tour and Saturn Orbit Insertion Probe Checkout November 2004 Probe Checkout December 2004
Deep Impact Flyby	Launch December 2004
Genesis	Earth Return August 2004 Back-up Orbit September 2004
GSSR	Asteroid 6239 MINO January 2004 Asteroid 1998SF36 June 2004
ISTP SOHO	SOHO HSO May 2004
MER1	EDL and Surface OPS January 2004
MER2	EDL and Surface OPS January 2004
Mars Reconnaissance Orbiter	Launch August 2004
MESSENGER	Launch March 2004 Venus Flyby 1 June 2004
Stardust	Comet P/Wild2 Encounter January 2004 Encounter Data Playback January 2004
Ulysses	Jupiter Encounter January 2004 Meridional and Radial Alignment February 2004
Voyager 1	MAGROL Maneuver DTR Array Playback ASCAL Maneuver
Voyager 2	MAGROL Maneuver DTR Playback ASCAL Maneuver

TABLE 3: Major Events for 2005

PROJECTS	2005 EVENTS
Cassini	Probe Release January 2005 Probe Entry January 2005 Saturn Tour January 2005
Deep Impact Flyby **Deep Impact Flyby**	Comet Approach/Encounter May 2005 Comet Impact July 2005
GSSR	Asteroid 1998WT March 2005
ISTP SOHO	HSO June 2005
STEREO Ahead	Launch November 2005
STEREO Behind	Launch November 2005
Voyager 1	MAGROL Maneuver DTR Array Playback ASCAL Maneuver
Voyager 2	MAGROL Maneuver DTR Array Playback ASCAL Maneuver

Supporting Data cont.

Major Events for 2003-2007 cont.

TABLE 4: Major Events for 2006

PROJECT	2006 EVENTS
DAWN	Launch May 2006
ISTP SOHO	HSO January 2005-April 2006
MESSENGER	Venus Flyby 2 February 2006
Mars Reconnaissance Orbiter	Mars Approach January 2006 Mars Orbit Insertion and Aerobraking March 2006
New Horizons Pluto Charon	Launch January 2006
Voyager 1	MAGROL Maneuver Array DTR Array Playback ASCAL Maneuver
Voyager 2 - 2006	MAGROL Maneuver DTR Playback ASCAL Maneuver

TABLE: 5 Major Events for 2007

Projects	2007 EVENTS
ISTP SOHO	HSO May 2007
Lunar-A	Launch August 2007 Lunar Orbit Injection
Mars Completed Scout 2007	Launch August 2007
MESSENGER	Mercury Flyby 1 July 2007
MUSES-C	Earth Re-Entry May 2007
New Horizons Pluto Charon	Jupiter Approach January 2007 Jupiter Flyby March 2007
Voyager 1 - 2007	MAGROL Maneuver DTR Array Playback ASCAL Maneuver
Voyager 2 - 2007	MAGROL Maneuver DTR Playback ASCAL Maneuver

Supporting Data cont.

Monthly User Lost Time by Subnet

Chart 8: 2003 Monthly User Lost Percentage

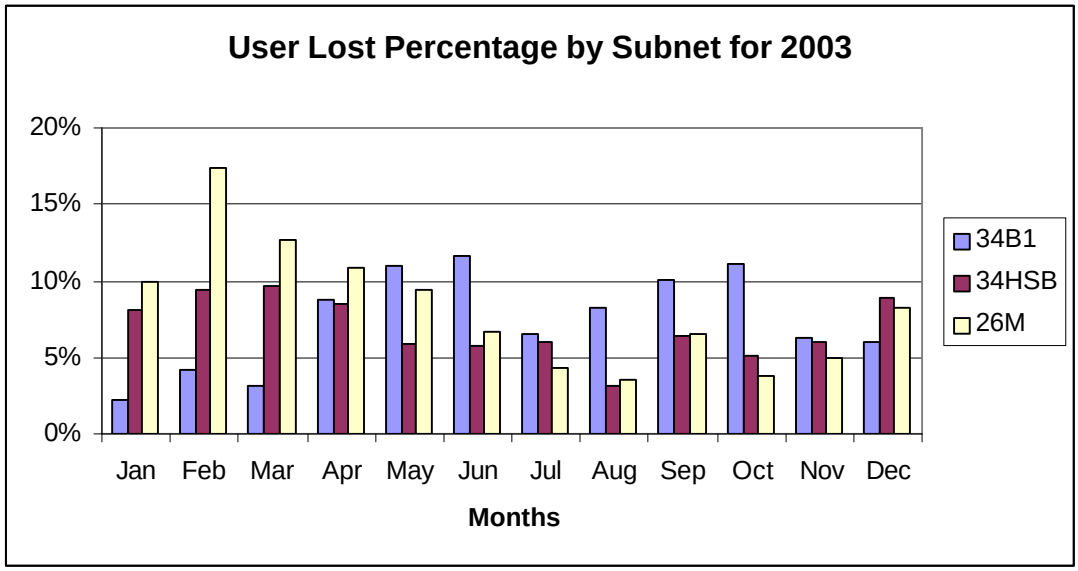
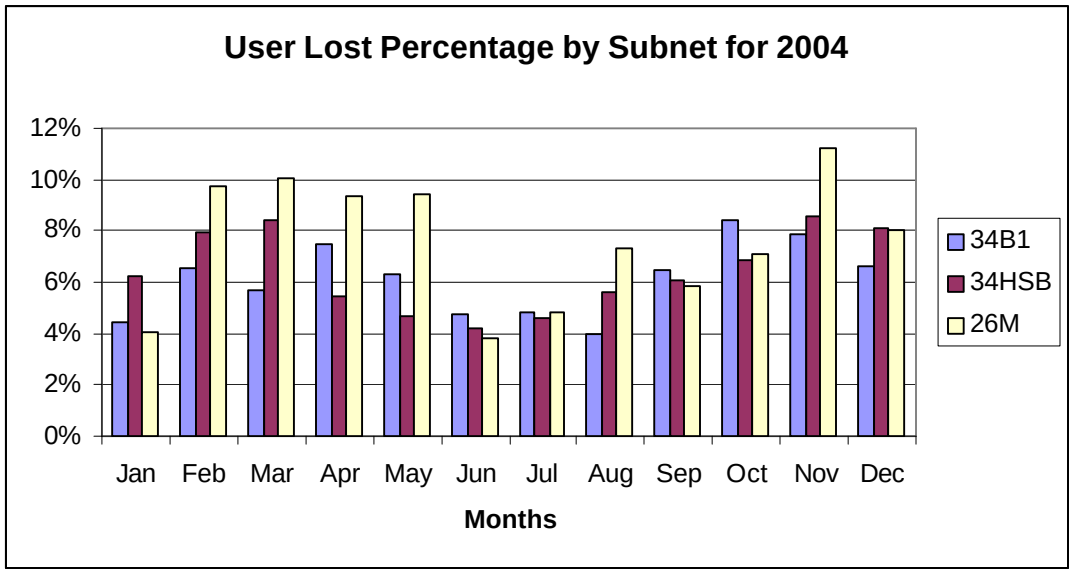


Chart 9: 2004 Monthly User Lost Percentage



Supporting Data cont.

Monthly User Lost Time by Subnet cont.

Chart 10: 2005 Monthly User Lost Percentage

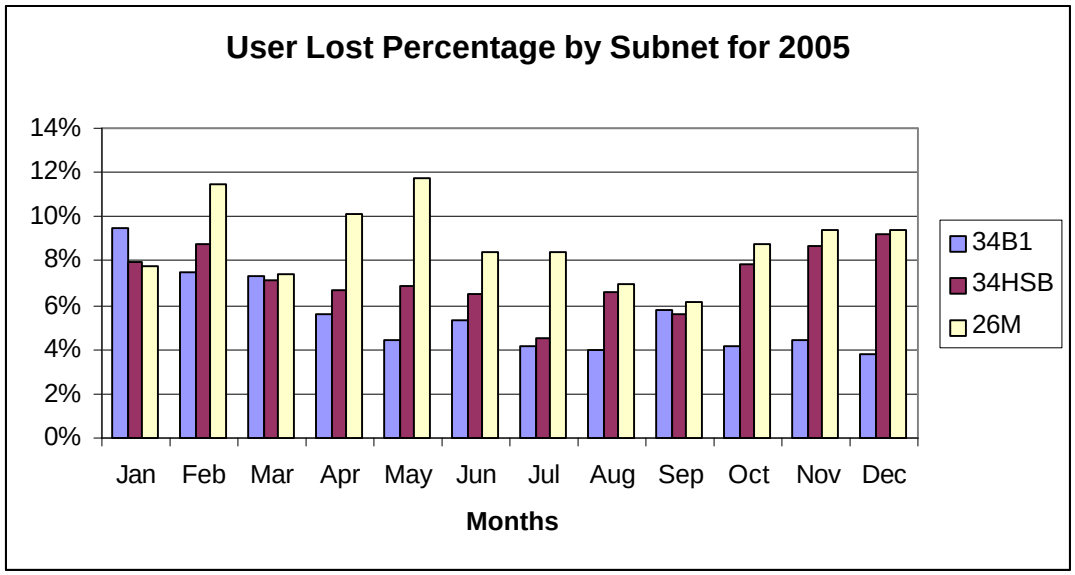
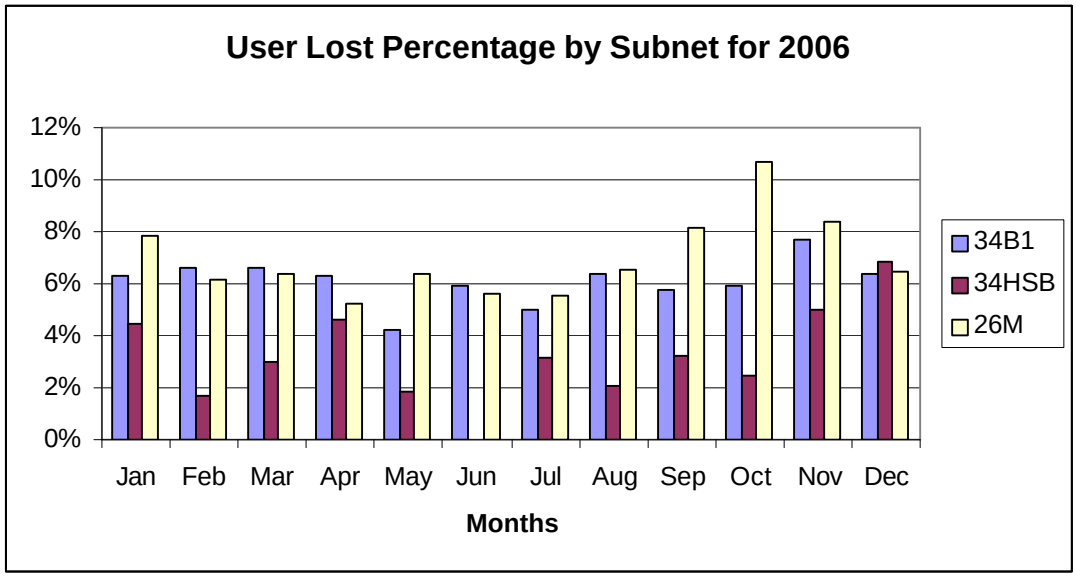


Chart 11: 2006 Monthly User Lost Percentage



Supporting Data cont.

Monthly User Lost Time by Subnet cont.

Chart 12: 2007 Monthly User Lost Percentage